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Exchange Rate Cycles and Canada–U.S. Manufacturing Prices

by John R. Baldwin and Beiling Yan

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Abstract

During the post-1970 period, Canadian manufacturing prices have alternately increased and fallen relative to U.S. prices—just the reverse of the cycle in the Canada–U.S. exchange rate. But not all manufacturing industries have experienced the same amplitude of relative price changes. This paper examines the industry characteristics that are related to the shifts in competitiveness, measured as the relative price ratio between Canadian prices and U.S. prices adjusted by the exchange rate. We find that relative factor input costs and relative productivity growth are the two most important factors influencing changes in relative Canada–U.S. prices. Competitive pressures emanating from trade are important determinants of the extent to which relative productivity differences are passed through to cross-country relative prices in the manufacturing sector. We also find that the magnitude of domestic market competition and export intensity affects the short-run relative price shifts over the cycle of exchange rate.

Keywords: exchange rate, real exchange rate, prices, international competitiveness, productivity, industry characteristics

JEL Code: E30, F31, L60

Executive summary

Over the last 40 years, the Canadian–U.S. exchange rate has gone through several long cycles, alternating between periods of appreciation and depreciation. During each of these cycles, the competitiveness of the Canadian manufacturing sector has changed dramatically. During periods of exchange rate appreciation, the competitiveness of Canadian industries, as measured by the relative price ratio between the Canadian price and exchange rate-adjusted U.S. price, has on average declined; during periods when the Canadian dollar depreciated, it increased.

Not all industries experienced the same change in prices relative to their U.S. counterparts. In this paper, we explore which characteristics are related to the rate at which the Canada–U.S. price ratio increased or decreased over periods of exchange rate appreciation or depreciation.

We find that production costs, such as the costs of labour, energy and material, and productivity growth are the two most important determinants of international competitiveness. Higher Canadian than U.S. productivity growth translates into a relatively lower Canadian than U.S. output price, and thus, a rise in the Canadian industry's international competitiveness. Higher Canadian than U.S. input cost increases translate into a relatively higher Canadian than U.S. output price, and thus, a fall in the Canadian industry's international competitiveness.

The amount of pass-through from productivity growth to output prices is however not constant. It is greater in periods of exchange rate appreciation when competitive pressures from United States goods are greater. It is lower in periods of depreciation when competitive pressures from United States goods are less. Competitive pressures emanating from trade are therefore important determinants of the extent to which relative productivity differences in manufacturing are passed through to cross-country price differences in the short run.

It is also the case that the size of the relative price movement over exchange rate cycles depends on the export intensity of the industry and the degree of domestic market competition. In industries that are more export-intensive or more concentrated, relative prices are less affected by fluctuations in the exchange rate. This is consistent with a world in which Canadian exports are priced exactly or closely to U.S. levels, and changes in the exchange rate will therefore be passed directly through to the average Canadian price charged. This is also consistent with a world in which markets with less domestic competition are more able to adjust their prices to landed U.S. prices, and changes in the exchange rate will therefore be passed directly to Canadian prices. In such a world, exporters or industries with market power adjust to competitive pressures from trade over exchange rate cycles by squeezing or swelling their profit margins.

1. *Introduction*

This paper focuses on movements in Canada–U.S. prices since 1960 in the manufacturing sector using matched industry data for these two countries. During the post-1970 period, Canadian manufacturing prices have alternately increased and fallen relative to U.S. prices—just the reverse of the cycle in the Canada–U.S. exchange rate. Not all manufacturing industries have experienced the same amplitude of relative price changes. This paper examines the industry characteristics that are related to the shifts in competitiveness, measured as the relative price ratio between Canadian prices and U.S. prices adjusted by the exchange rate.

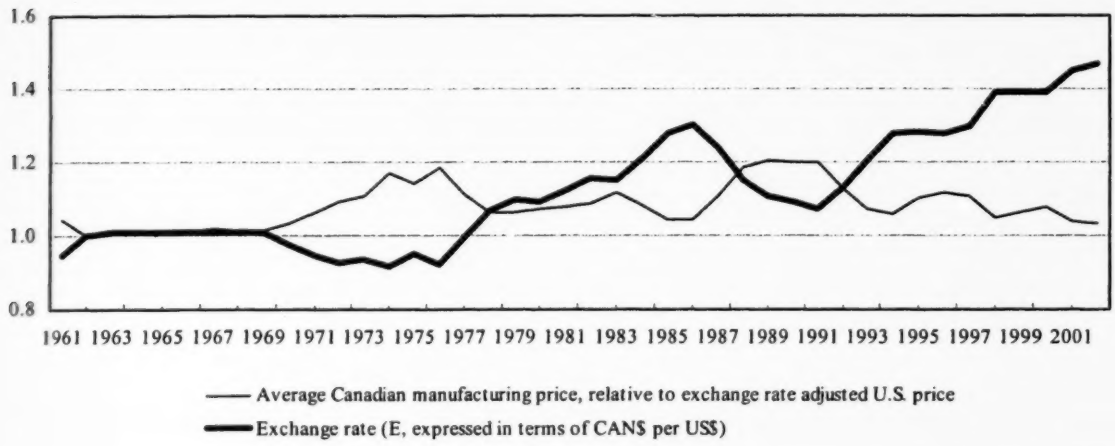
The course of relative Canada–U.S. prices is of interest to international trade analysts who focus on the relative performance of the two economies. With diminishing trade barriers and increasing integration of world markets, industries and policy makers have become more concerned with their international competitiveness. One variable that can be used to gauge an industry's competitiveness is the relative price—the ratio of an industry's product price relative to the price (after being adjusted by the exchange rate) charged by industries in other countries. If the relative price ratio for an industry has a downward trend, then the industry is becoming more competitive relative to its foreign counterpart.

Productivity analysts also focus on movements in relative prices. Those who measure the gap in levels of productivity across countries possessing different currencies need estimates of relative price levels to transform measures of relative gross domestic product (GDP) estimated in different currencies to measures of 'real' output differences. To do so, they calculate purchasing power parities (PPPs). Sometimes, exchange rates are used for this purpose. At other times, they are calculated directly from collections of prices for a large bundle of commodities in each country. But in most countries, the number of commodities that are collected per industry is small, provide only imperfect coverage at the industry level and are therefore, inadequate for industry studies of cross-country productivity gaps.[1] Alternatives that are used sometimes focus on commodity data that are collected from surveys associated with the collection of manufacturing statistics. These are both expensive to estimate and rarely provide a long time series that can be used to estimate long-run performance of sectors. It is therefore critical to have estimates of relative price changes over time to complement cross-country benchmark estimates of price levels so that the correct estimates of relative price levels may be developed for years other than the benchmark year. The paper focuses on the behaviour of relative industry price changes over time.

Figure 1 plots the average relative price ratio from the 1960s to the 1990s for the Canadian and U.S. manufacturing sector.[2] The figure plots the ratio of changes in Canadian prices relative to changes in U.S. prices corrected for shifts in the exchange rate. The changes are all indexed to an initial value of 1 at the beginning of the period in 1962. It is evident that the relative Canada–U.S. price ratio is negatively correlated with the exchange rate. The nominal exchange rate between Canada and the United States has undergone several cycles since 1970, when Canada floated its dollar after a period of a fixed exchange rate against the U.S. dollar. The Canadian dollar appreciated relative to the U.S. dollar from 1970 to 1976, followed by a period of depreciation

1. See Baldwin, Maynard et al., 2005.
2. For the sources of data, see Section 3.

Figure 1 Exchange rate and relative price (1996=1)


1.6
1.4
1.2
1.0
0.8
1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001
Average Canadian manufacturing price, relative to exchange rate adjusted U.S. price
Exchange rate (E, expressed in terms of CAN$ per US$)

Source: Canadian data based on Capital, Labour, Energy, Materials and Services (KLEMS) database, American data based on the National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies (NBER-CES) productivity database.

from 1976 to 1986. During the second half of the 1980s the Canadian dollar staged a strong recovery, but after 1991 it declined steadily from 87 cents (U.S.) to only 64 cents in 2002.

When the exchange rate first appreciated in the 1970s, the Canadian average manufacturing price (corrected for the exchange rate) increased relative to the American price. When the exchange rate began to depreciate in the late 1970s, the relative price moved downwards. When an appreciation cycle began in the mid 1980s, the relative Canadian price once more moved up; when the exchange rate again began to depreciate, the relative price moved back down once again.

All of this indicates that the relative Canada–U.S. price involves a component that does not adjust to exchange rate movements immediately. When the Canadian dollar appreciates, the price of U.S. goods landed in Canada falls, thereby placing pressure on domestic Canadian producers. An increasing exchange rate corrected Canada–U.S. relative price during these episodes (shown in Figure 1) implies that Canadian prices do not adjust downward fully to reflect the lower American landed price in Canada. On the other hand, when the Canadian dollar depreciates, the price of American goods landed in Canada increases. A falling relative price ratio implies that the Canadian price is not increased hand in hand with changes in the landed American price.

That Canadian prices are sticky relative to U.S. prices suggests that competition is not sufficiently intense to equate the prices of the two markets—at least in the short run. Goods produced by the same industry are not perfectly substitutable. Canadian firms that allow the price ratio to increase during a period of an appreciating exchange rate either have little to worry about in the way of lost sales or make a conscious decision to lose market share slowly. Firms that allow the price ratio to narrow during a period of a depreciating exchange rate are doing the reverse.

Until now, our discussion has treated the manufacturing sector as a homogeneous entity. In reality, the magnitude of Canada–U.S. relative price changes varies across industries (Bernard, Warren and Yan, 2005). In some instances, there have been substantial upward movements in the relative price ratio—Diary Products, Brewery Products, Record Player, Radio and Television, Communication and Other Electronic Equipment, and Office, Store or Business Equipment. In other instances, there have been substantial downward movements in the relative price ratio—Steel Pipe and Tubes, Copper and Alloy Rolling, Casting and Extruding, Metal Products, and Motor Vehicle Parts and Accessories.

These industry differences in the movement of relative prices pose the question: why have some Canadian industries become more competitive relative to their U.S. counterparts, while some have become less competitive? What are the factors that underlie an industry's ability to hold down its price increases, and therefore, to achieve stronger competitiveness relative to its foreign competitors? Can the heterogeneity of markets provide an explanation for variations in the rigidity of Canadian manufacturing prices relative to U.S. prices?

This paper contributes to the purchasing power parity (PPP) or the Law of One Price (LOP) literature, one of the most enduring concepts in international economics. Most studies of PPP, or the extent to which exchange-rate effects are passed through to local markets, focus on the prices of commodities and then primarily on the pass-through of exchange-rate changes on import or export prices.[3] Most articles in the extensive empirical work that have tested the validity of PPP either use aggregate national price indices or more disaggregated price data of individual commodities.[4] Baldwin and Yan (2004) make use of commodity price data derived from the Canada–U.S. Bilateral PPP Programme of Statistics Canada to ask whether Canadian prices in recent years have equated to U.S. prices after the implementation of the North American Free Trade Agreement.

In this paper, we extend their research to a longer period. To do so, we move from examining the relative prices of commodities to investigating the relative prices of industries for three reasons. First, consistently defined commodity data are not available for the 40-year period that we investigate; second, we are ultimately interested in examining how productivity levels have changed at the industry level and this requires us to focus on industries; third, we are inherently interested in whether there are industry characteristics that may influence the movement in relative prices, that is whether short-run movements differ across industries in a meaningful way.

It is less common to find research that examines how the movement in the relative price at the industry level is related to industry characteristics, such as the nature of domestic market competition, the extent of product differentiation, the degree of trade orientation, and the difference in productivity growth.[5] The LOP hypothesis is implicitly based on the assumption

3. See Menon (1995) for a summary of articles on exchange-rate pass-through.
4. See survey articles by Froot and Rogoff (1995), and Rogoff (1996).
5. Several studies have examined industry pricing behaviour for home producers under imperfect competition and product differentiation. These country studies include Feinberg (1989) for the United States; Feinberg (1986) for Germany; Kardasz and Stollery (1998, 1988), and Karikari (1988) for Canada; Bloch (1992), and Bloch and Olive (1999) for Australia. This paper is similar to the above studies in that we are interested in the impact of industry characteristics on prices, but it differs in its objective. It is more concerned with the explanations for the movement of relative price ratio, a measurement of international competitiveness, rather than with the determinants of domestic prices, which is the focus of most of the other studies.

that domestic and foreign goods are perfect substitutes and are traded in perfectly competitive and integrated world markets. If industries differ in the degree to which goods are perfect substitutes across countries, or in their intensity of competition, we might expect industry prices to vary in terms of their adherence to the LOP. If so, the direction and the magnitude of relative Canada–U.S. price movements may vary across industries. It is this issue that we examine here.

The remainder of the paper is organized as follows. Section 2 provides the empirical framework by identifying factors that could potentially have an impact on the movement of relative Canada–U.S. prices. It specifies the empirical equations to be estimated. Section 3 describes the data sources and measurement issues. Section 4 reviews panel estimation results. And section 5 concludes.

2. *Empirical framework*

2.1 *Literature review*

In assessing how the competitiveness of Canadian industries has changed relative to their U.S. counterparts, we examine changes in the relative price ratio (RP_i), defined as changes in the Canadian output price index of industry i (P_i^c) divided by changes in the U.S. output price index (P_i^u) adjusted by changes in the market exchange rate (E, expressed in terms of CAN$ per US$). That is, for industry i in year t: $RP_i = (P_i^c / EP_i^u)$.[6] For abbreviation, we omit the subscript i in the subsequent notations.

There are two extreme strands of models on price formation. One assumes completely segregated markets where prices are subject to the mark-up pricing rule. Prices are a mark-up of the domestic cost of production. The other assumes perfectly integrated markets where prices are subject to the Law of One Price rule. Prices in domestic markets are determined by world prices. We draw on both to guide us in our choice of variables that are likely to influence cross-country relative price movements.

All of the market-based models have output price related to marginal costs—the markup pricing rule. Consider the technology of firms to be characterized by a production function $Q=Q(X,A)$ or by a dual variable cost function $C=C(W,Q,A)$, where X is a vector of J variable inputs, W is a corresponding vector of input prices, Q is real gross output, and A denotes the state of technology. When domestic markets are completely segregated from world markets and are perfectly competitive, output price (P) equals the marginal cost of production (C'): $P = C'(W,Q,t)$.[7] Total differentiating yields:

---

6. We focus on changes in the relative prices over each of the cycles because of our intrinsic interest in these changes, but note that first-differencing is often used to handle non-stationarity of time series variables in the pass-through literature.
7. In a more general case, output price for each firm can be expressed as $P = \mu C'(W,Q,t)$, where μ is a function of own price elasticity of demand, cross-price elasticity of demand, and conjectural variation which reflects the strategic interactions among firms. In this case, mark-up μ depends both on the extent of product substitution, and on the form and the degree of market competition.

$$\Delta \ln P = \sum_j \alpha_j \Delta \ln W_j + \alpha_Q \Delta \ln Q + \alpha_A \Delta \ln A \qquad (1)$$

where the symbol 'Δ' denotes first-differences, $\alpha_j = (\frac{\partial \ln P}{\partial \ln W_j})$, $\alpha_Q = (\frac{\partial \ln P}{\partial \ln Q})$, and $\alpha_A = (\frac{\partial \ln P}{\partial \ln A})$. Coefficients α measure elasticities of output prices with respect to input prices, output and technology respectively. Assuming similar elasticities in the two countries, changes in relative Canada–U.S. output prices could be written as:[8]

$$\begin{aligned}
\Delta \ln RP &= \Delta \ln(\frac{P^c}{EP^u}) = \Delta \ln(P^c) - \Delta \ln(EP^u) \\
&= \sum_j \alpha_j [\Delta \ln W_j^c - \Delta \ln(EW_j^u)] + \alpha_Q [\Delta \ln Q^c - \Delta \ln Q^u] + \alpha_A [\Delta \ln A^c - \Delta \ln A^u] \\
&= \sum_j \alpha_j \Delta \ln(\frac{W_j^c}{EW_j^u}) + \alpha_Q \Delta \ln(\frac{Q^c}{Q^u}) + \alpha_A \Delta \ln(\frac{A^c}{A^u}). \qquad (2)
\end{aligned}$$

Equation (2) indicates that changes in relative cross-country output prices depend on cross-country differences in input price changes, output growth and technology improvement. Improvements in technology ($\Delta \ln A$), for example, shift the production frontier, which is captured by productivity growth. Relative productivity growth is important because, in competitive markets, productivity gains are passed on to consumers in terms of lower prices. Baldwin, Durand and Hosein (2001) demonstrate that differences in productivity growth across Canadian industries are reflected mainly in differences in price changes, rather than in wage changes. The same phenomenon is likely to be found across countries. A Canadian industry's prices are likely to go up less relative to the United States when industry productivity goes up more in Canada than it does in the United States. Similarly, Canadian prices are likely to go up more when Canadian productivity growth is lower than American productivity growth.

The other extreme found in the pricing literature is the Law of One Price rule, which states that an identical product sells for the same common currency price in different countries, i.e., (P^c / EP^u). It implies that any changes in prices of competing foreign products will be fully passed through to domestic prices, particularly for a small open economy as Canada. In such a world, domestic prices for an appreciating currency, for example, will be adjusted downward by the full amount of the change in the exchange rate.

The assumptions required for the Law of One Price to hold are perfect product substitution, perfect market competition and integration, and costless transportation, distribution and resale. Under imperfect substitution, competition and integration, and adjustment costs, the pass-through will be incomplete. Various models and empirical tests have been developed to explain the deviation from the Law of One Price or the incomplete pass-through. One obvious explanation is that of short-term price rigidities due to menu costs—transaction costs associated

8. Since the cost function is homogeneous of degree one in W, the price-cost equation could be written as $EP^u = C^i(EW^u, Q, t)$ where E is the exchange rate.

with repricing, reputation effects, or sunk costs associated with the establishment of a distribution and after-sales network. Prices are not instantly adjusted to changes in exchange rates. The menu costs lead to stickiness because exchange rate movements are expected to be only transitory and firms fight to either stay in the market or deter entry (Frankel and Rose, 1995; Kasa, 1992; Krugman, 1989; Dixit, 1989; and Baldwin, 1988).

Another explanation for the incomplete pass-through focuses on the role of market structure, product differentiation and market segmentation. This strand of literature models differences in prices as a result of simple shifts in demand that result in changes in prices that reflect basic demand and supply elasticities. Part of this group is composed of those who build models of monopolistic price competition or of oligopolistic price setting that depends on the type of conjectural variations and that has, as its foundation, reaction curves that depend on the state of competition at the industry level and the degree of product differentiation.[9]

Using the Cournot model, the Dixit-Stiglitz model and Salop's model of competition, Dornbusch (1987) demonstrates that an appreciation should lead to a decline in the price of imports, and that the extent of domestic firms matching the decline in price depends on the relative number of foreign and home firms, on a measure of competition, and on the degree of product differentiation between domestic and imported goods.

Sibert (1992) extends and generalizes Dornbusch's result that the response of domestic prices to exchange-rate changes is positively related to the ratio of the number of foreign firms to total firms under a variety of behavioural assumptions. This seems to suggest that the larger is the share of imports in total sales, the more adjustment there will be in Canadian prices to shifts in the exchange rate, and thus the relative Canada–U.S. price ratio will be less volatile.

Kardasz and Stollery (2001) and Feinberg (1989) find that the pass-through of exchange-rate changes to domestic prices increases with the substitutability of imports and domestic goods. In industries where products are differentiated, domestic prices may be less responsive to changes in the exchange rate. Relative prices may change if consumers do not switch quickly from the products of producers in one country to the products of producers of the other country when the exchange rate changes. And this is more likely to occur when products are differentiated, since in this instance, substitution in response to widening price differences does not occur as rapidly as in industries with homogeneous undifferentiated products. We may, therefore, expect Canadian prices in industries with more differentiated products to be stickier, and that Canada–U.S. relative prices are likely to fluctuate more with changes in the exchange rate in these cases.

Recent empirical studies (Bloch and Olive, 1999; Bloch, 1992; and Fischer, 1989) also find a higher impact of foreign prices on domestic prices if the domestic market is more concentrated. Intuitively, if an industry is more competitive, the mark-ups of domestic producers will probably be low and, consequently, their ability to compete with foreign prices by cutting mark-ups when competition from imports becomes more intense will be limited. Adjustment to changes in foreign prices occurs more on the quantity side than on the price side in more competitive industries. As domestic industries become more concentrated, higher markups develop and

9. For literature survey on the exchange-rate pass-through literature, see Menon (1995), and Goldberg and Knetter (1997).

provide more room to adjust prices to foreign competition. We therefore expect that in more competitive industries, there will be less adjustment in Canadian prices to shifts in the exchange rate and more volatility in the relative Canada–U.S. price ratio. As outlined in the next section, we develop a special variable to capture the influence of competitive conditions in an industry.

Apart from imperfect product substitution in the context of imperfect competition, market segmentation is another factor that could determine the price-setting power of firms and thus, the leverage available to them in responding to changes in the exchange rate. In the pricing to market framework (Krugman, 1987), oligopolistic suppliers are able to charge different prices for the same goods sold in different markets, such as the domestic and the export markets. It appears that the local currency prices of foreign products do not respond fully to exchange-rate changes. In many cases half or more of the effect of an exchange-rate change is offset by adjustments in the markup of exporters (Knetter, 1989; Marston, 1990; and Gagnon and Knetter, 1995). For example, Schembri (1989) examines pricing behaviour of Canadian export industries and finds that the depreciation of the Canadian dollar led to an increase in the Canadian price of exports.

The pricing-to-market phenomenon has implications for the movement in relative Canada–U.S. prices. The price of products produced by a Canadian industry is an average of those products going to domestic markets and those going to export markets. Let P^d be domestic price, P^x export price and s export share. Then $P^c = (1-s)P^d + sP^x$. The pricing to market phenomenon implies that changes in exchange rate will more likely lead to adjustment in the Canadian price of exports rather than be passed through to U.S. consumers. It may be that market imperfections differ between domestic and foreign markets. U.S. markets are much less concentrated than Canadian markets. They may therefore be more competitive. If so, it is less likely that a price gap will develop (or that the price gap that develops will be smaller) between Canadian exports and U.S. goods in U.S. markets. Therefore, for Canadian exported goods, price pass-through from U.S. markets to the Canadian price of exported goods is likely to occur when the exchange-rate changes (or the pass-through will be relatively large) and this will affect the average price of all Canadian produced goods, which includes goods going to Canadian domestic markets and those going to export markets. The larger the share of domestic goods produced that are exported, the greater will be the adjustment in Canadian prices to a given shift in the exchange rate, and the less will be the changes in the common currency relative price ratio (P^c / EP^u).

The pricing-to-market hypothesis can also be applied to imports. In the pricing-to-market model that presumes market segmentation between Canada and the United States, and where importers may fix their price in Canadian dollars, we would expect high volatility in the relative Canada–U.S. price ratio as the exchange rate fluctuates. That volatility is probably greater where imports shares are less, if the necessity to price to Canadian markets is higher in the case where imports are relatively unimportant. This accords with predictions from the Dornbusch (1987) and Sibert's (1992) models that the relative price ratio for industries with higher import shares will be less volatile. Where the pressures to price to market are not related to the import market share, there will be no relationship between import market share and the volatility of relative prices.

The above exchange rate pass-through literature that examines the price setting behaviour in the context of open economy suggests that the extent of the response of domestic prices to changes in competing foreign prices depends on the following four domestic industry characteristics: the

extent of import competition (*MSH*), the intensity of domestic market competition (*COM*), the degree of product differentiation between imports and domestic products (*DIF*), and export intensity (*EXP*). That is:

$$\Delta \ln RP = \Delta \ln(\frac{P^c}{EP^u}) = \Delta \ln(P^c) - \Delta \ln(EP^u) = f(MSH, DIF, COM, EXP). \quad (3)$$

The two extreme pricing models—the markup pricing rule and the law of one price rule—help us to understand different aspects of pricing behaviour of firms. The former assumes a segmentation of Canadian and U.S. markets and emphasizes the effect of costs on pricing. The latter assumes integration of the world economy and stresses international influences on domestic prices. Each model may be correct to some degree and both domestic and foreign forces may play a role in affecting relative prices. As Kardasz and Stollery (1998, 1988) show, domestic cost of production and foreign prices are both important determinants of Canadian manufacturing prices. In our empirical analysis, we therefore include both domestic and foreign factors. We examine the extent to which the Canada–U.S. relative price at the individual industry level is related to the relative changes in the two countries in productivity, input prices and output growth, and the domestic industry characteristics such as the extent of export intensity, domestic market competition, product differentiation and import competition.

2.2 *Empirical specification*

The above literature overview suggests an estimation equation of the following form:

$$\Delta \ln RP = \alpha_0 + \alpha_1 \Delta \ln(\frac{A^c}{A^u}) + \alpha_2 \Delta \ln(\frac{W^c}{EW^u}) + \alpha_3 \Delta \ln(\frac{Q^c}{Q^u})$$

$$+\alpha_4 EXP + \alpha_5 COM + \alpha_6 DIF + \alpha_7 MSH + \varepsilon \quad (4)$$

where (W^c, W^u) are composite price indices for variable inputs in Canadian and U.S. industries, and ε represents error terms.

The exchange rate between Canada and the United States has undergone several cycles since 1970. The direction and the magnitude of exchange-rate movements exert different competitive pressures on Canadian industries. For example, when the Canadian dollar appreciates, the landed price of Canadian exports in the U.S. increases relative to U.S. domestic products, thereby putting more price pressure on domestic producers that export.[10] Alternately, the appreciating dollar brings down the landed price of U.S. imports to Canada and places more pressure on Canadian production that is destined for Canadian consumers. By contrast, when the Canadian dollar depreciates, there will be less price pressure on both Canadian exporters and non-exporters.

10. We assume here, for expositional purposes, that U.S. goods landed in Canada are priced at U.S. levels corrected by the exchange rate. If exchange-rate changes associated with appreciation are not passed through completely, U.S. import prices landed in Canada will still fall, but not by as much.

Because the competitive pressures that are placed on domestic Canadian producers differ during periods of Canadian dollar appreciation as opposed to depreciation, it is possible that the impact of industry characteristics on the relative Canada–U.S. price ratio depends on the direction and magnitude of exchange-rate movements. We therefore divide the whole period of floating exchange rates (1970 to 1996) into five sub-periods corresponding to the appreciation and depreciation cycles of the Canadian dollar relative to the U.S. dollar: two periods of appreciating Canadian dollar (1970 to 1976; 1986 to 1991) and three periods of depreciating Canadian dollar (1976 to 1981; 1981 to 1986; and 1991 to 1996). We use the complete period in each case rather than individual years, because we wish to separate long-term trends from short-run adjustments.

The impact of industry characteristics on relative price movements can be estimated separately for periods of appreciation and periods of depreciation using equation (4). Alternatively, we could introduce interaction terms between independent variables and the proportional changes in exchange rate (E). That is:

$$\begin{aligned}\Delta \ln RP = {} & \alpha_0 + \alpha_1 \Delta \ln\left(\frac{A^c}{A^u}\right) + \alpha_2 \Delta \ln\left(\frac{W^c}{EW^u}\right) + \alpha_3 \Delta \ln\left(\frac{Q^c}{Q^u}\right) \\ & + \alpha_4 EXP + \alpha_5 COM + \alpha_6 DIF + \alpha_7 MSH \\ & + \beta_1 \Delta \ln\left(\frac{A^c}{A^u}\right)\Delta \ln E + \beta_2 \Delta \ln\left(\frac{W^c}{EW^u}\right)\Delta \ln E + \beta_3 \Delta \ln\left(\frac{Q^c}{Q^u}\right)\Delta \ln E \\ & + \beta_4 (EXP)\Delta \ln E + \beta_5 (COM)\Delta \ln E + \beta_6 (DIF)\Delta \ln E + \beta_7 (MSH)\Delta \ln E + \varepsilon . \qquad (5)\end{aligned}$$

Specification (5) in contrast to specification (4) not only takes into account the direction of the exchange-rate change, but also the magnitude of the change. The α coefficients measure the impact of independent variables on the relative price ratio after controlling for short-run fluctuations in the exchange rate. The estimates can thus be interpreted as long-run average impacts when there is no fluctuation in the exchange rate. The short-run impact of an independent variable on relative price is $\alpha + \beta \Delta \ln E$, where β coefficients measure how the short-run impact differs from the long-run impact in response to changes in the exchange rate. We estimate and report results using both specifications.

3. *Data source and measurement*

Data on output prices, factor input prices and productivity are derived from the Canadian productivity (KLEMS) and the U.S. NBER-CES productivity databases. The NBER database covers 459 U.S. manufacturing industries from 1958 to 1996. They are matched and aggregated to the Canadian P-level[11] of aggregation (at the three- and four-digit SIC level). The final dataset covers 84 manufacturing industries from 1961 to 1996. Output price indices are deflators for gross output. Factor input price indices are weighted averages of implicit Fisher price indices for labour, energy and material. Productivity is calculated as gross output multifactor productivity

11. The P level is used by the Canadian Productivity Accounts and is derived from the Canadian input-output tables. This level of aggregation lies between the M and the L level of the Canadian input-output accounts.

growth—the difference between the growth in output and the growth in a bundle of inputs. All three variables are measured with base year 1987=1.

Two alternative measures of the intensity of market competition are used here: firm turnover measures and concentration ratios. The measurement of market competition has usually focused on the size distribution of firms in an industry.[12] The most widely used is the four-firm concentration ratio—the percentage of output accounted for by the four largest firms in an industry. However, these size-related statistics typically present a picture of considerable stability over time and do not reflect the substantial change that is taking place within industries, as firms enter, exit, grow and decline. Measures of turnover or intra-industry mobility more directly capture the amount of change that is taking place in an industry when some producers supplant others as a result of the competitive process. The extent and the patterns of intra-industry turnover, their relationship to the intensity of competitive process, and their importance to market performance are examined in detail by Baldwin (1995).

To summarize the intensity of competition, principal-component analysis is used. Principal-component analysis is useful when there are a number of related yet different measures of a given phenomenon. The first principal component of a set of variables is a weighted average of the original variables in which the weights (eigenvectors) are chosen to make a new composite index (principal component). It reflects the maximum possible proportion of the total variation in the set. Each succeeding component, unrelated to previous ones, can be similarly calculated to maximize the proportion of the remaining variation in the original variables. One simple criterion for selecting the number of principal components in further regression or analysis is to retain components with associated eigenvalues greater than the average eigenvalue (Kaiser, 1958).

Both the turnover rate and the four-firm concentration ratio measures, derived from Statistics Canada's Annual Survey of Manufactures,[13] are used for the principal component analysis. The turnover rate is calculated as the sum of the turnover arising from entry and exit, measured as the employment share of entrants and exits, and the turnover rate arising from continuing firm growth and decline, measured as the share of employment gain and loss from growers and decliners. It covers the period from 1973 to 1996. The four-firm concentration ratio is calculated as the percentage of output accounted for by the four largest firms. It covers the period from 1974 to 1996.

The results are presented in Table 1. The first principal component is a composite index of overall intensity of domestic market competition, since the first eigenvector has similar loadings on both variables. It has a positive loading on turnover and a negative loading on the 4-firm concentration ratio. A higher value of the first principal component therefore should be interpreted as being associated with more competition. We use the first principal component (*PRN1*) in our regression since it explains about 71% of the total variance and its eigenvalue is greater than the average eigenvalue.

12. See Baldwin (1995, ch. 7).
13. For the latter purpose, we use the longitudinal version of the file maintained by the Micro-economic Analysis Division.

Table 1 Principal-component analysis for market competition

Competition variable	Eigenvector	
	PRN1	PRN2
Turnover rate (TRN)	0.71	0.71
Four-firm concentration ratio (CON4)	-0.71	0.71
Proportion of total sample variability accounted for	0.71	0.29
Eigenvalue	1.42	0.58

Note: PRN=Principal component.
Source: Statistics Canada's Annual Survey of Manufactures.

There are two alternative measures of product differentiation that we considered: the advertising-to-sales ratio and the Grubel and Lloyd intra-industry trade index. Product differentiation is related to the intensity of advertising. We postulate that when the proportion of expenses on advertising increases, product differentiation is generally higher. Intra-industry trade occurs when commodities are simultaneously both imported and exported. It is intimately associated with the notion of product differentiation (Grubel and Lloyd, 1975). Since both measures yield very similar analytical results, only those using Grubel's intra-industry trade index are reported here.

Export intensity is measured as the share of domestic production that is exported: exports divided by total shipments. Import share is measured as the share of imports in total domestic sales. The data are taken from Statistics Canada's input-output tables.

4. Panel regression results[14]

Equations (4) and (5) are estimated by pooling data for 84 industries over time periods.[15] All regressions include industry and time-period fixed effects. Results are presented in Table 2. Columns (1) to (3) of Table 2 contain results for Equation (4): Column (1) figures are pooled results for the periods when the Canadian dollar appreciates: 1970 to 1976 and 1986 to 1991; Column (2) figures are pooled results when the Canadian dollar depreciates: 1976 to 1981, 1981 to 1986 and 1991 to 1996; and Column (3) tests whether the differences between Column (1) and Column (2) are statistically significant, by introducing an interaction term between independent variables and a dummy variable representing depreciation periods. Column (4) contains estimation results for Equation (5) by pooling data for 84 industries over the 5 time periods: 1970 to 1976, 1976 to 1981, 1981 to 1986, 1986 to 1991, and 1991 to 1996.

14. To help understand the regression results, we include an Appendix table of summary statistics. For each of the five sub-periods, we divide observations into those in the top 25% and bottom 25% in terms of the percentage change in the relative Canada–U.S. industry price. The averages of the key variables for the top and bottom quartile observations for each period are presented in the table, along with the correlation coefficients.
15. We focus on changes in the relative prices over each of the cycles because of our intrinsic interest in these changes, but note that first-differencing is often used to handle non-stationarity of time series variables in the pass-through literature.

Table 2 Panel fixed effects model

Dependent variable: change in relative prices (Canadian prices relative to U.S. prices adjusted by exchange rate, $\Delta ln(RP)$)

Dependent variable	(1) Canadian dollar appreciation		(2) Canadian dollar depreciation		(3) Test with dummy for depreciation periods		(4) Pooled regression	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Change in the relative productivity of Canada to U.S. ($\Delta ln(A^c/A^u)$)	-0.606 **	(-10.36)	-0.351 **	(-8.51)	-0.606 **	(-10.42)	-0.441 **	(8.66)
Change in the relative input cost of Canada to U.S. ($\Delta ln(C^c/C^u)$)	0.509 **	(6.82)	0.573 **	(6.28)	0.509 **	(6.85)	0.501 **	(8.36)
Change in the relative output of Canada to U.S. ($\Delta ln(Q^c/Q^u)$)	0.053	(1.75)	-0.018	(-0.51)	0.053	(1.76)	0.018	(-0.69)
Export intensity (*EXP*)	-0.013	(-1.43)	0.011	(1.87)	-0.013	(-1.44)	-0.014	(-0.80)
Domestic market competition (*COM*)	0.002	(1.85)	-0.001	(-1.53)	0.002	(1.86)	0.004	(-1.63)
Product differentiation (*DIF*)	0.003	(0.57)	-0.005	(-1.33)	0.003	(0.58)	0.009	(-1.24)
Import share (*MSH*)	-0.001	(-0.15)	0.002	(0.44)	-0.001	(-0.15)	0.002	(-0.15)
$\Delta ln(A^c/A^u)$* depreciation periods' dummy	...	...	...	...	0.255 **	(3.57)	...	...
$\Delta ln(C^c/C^u)$* depreciation periods' dummy	...	...	...	...	0.065	(0.55)	...	...
$\Delta ln(Q^c/Q^u)$* depreciation periods' dummy	...	...	...	...	-0.071	(-1.53)	...	...
*EXP** depreciation periods' dummy	...	...	...	...	0.024 **	(2.23)	...	...
*COM** depreciation periods' dummy	...	...	...	...	-0.003 **	(2.39)	...	...
*DIF** depreciation periods' dummy	...	...	...	...	-0.008	(-1.27)	...	...
*MSH** depreciation periods' dummy	...	...	...	...	0.003	(0.37)	...	...
$\Delta ln(A^c/A^u)$* $\Delta ln(E)$ (change in exchange rate)	...	...	...	...	...	...	3.803 **	(2.81)
$\Delta ln(C^c/C^u)$* $\Delta ln(E)$ (change in exchange rate)	...	...	...	...	...	...	-1.814	(-0.77)
$\Delta ln(Q^c/Q^u)$* $\Delta ln(E)$ (change in exchange rate)	...	...	...	...	...	...	-0.855	(-0.93)
*EXP** $\Delta ln(E)$	...	...	...	...	...	...	0.484 **	(2.67)
*COM** $\Delta ln(E)$	...	...	...	...	...	...	-0.049 **	(2.40)
*DIF** $\Delta ln(E)$	...	...	...	...	...	...	-0.136	(-1.29)
*MSH** $\Delta ln(E)$	...	...	...	...	...	...	-0.003	(-0.02)
Observations	168	...	252	...	420	...	420	...
R-squared	0.67	...	0.45	...	0.80	...	0.85	...

... not applicable

* significant at the 5% level; ** significant at the 10% level

Notes: All regressions include industry and period dummies. Column (1) shows pooled results for the periods when the Canadian dollar appreciates: 1970 to 1976 and 1986 to 1991; Column (2) shows the pooled results when the Canadian dollar depreciates: 1976 to 1981, 1981 to 1986 and 1991 to 1996; and Column (3) tests whether the differences between the two exchange rate movements (appreciation vs. depreciation) are statistically significant by introducing an interaction term between independent variables and a dummy variable representing depreciation periods. Column (4) contains alternative estimation results based on Equation (5) by pooling 84 cross sectional industry data over the 5 time periods: 1970 to 1976, 1976 to 1981, 1981 to 1986, 1986 to 1991, and 1991 to 1996.

Source: Regression analysis based on Capital, Labour, Energy, Materials and Services (KLEMS) database and on the National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies (NBER-CES) productivity database and on Statistics Canada's Annual Survey of Manufactures.

The first finding is that there is a pass-through from higher Canadian productivity growth to lower Canadian output prices, and the pass-through from productivity to prices is larger in periods of Canadian dollar appreciation than in periods of Canadian dollar depreciation. This is evidenced by the significant negative correlation between changes in relative prices and changes in relative productivity for both the appreciation periods (-0.606 from Column 1) and depreciation periods (-0.351 from Column 2). The difference between the two is statistically significant, as demonstrated by the coefficient on the interaction term between changes in relative productivity and a time dummy for the depreciation periods (0.255 from Column 3). Results using specification (5) are consistent with those from Columns (1) to (3): the coefficient on the changes of relative productivity is negative (-0.441 from Column 4), and the coefficient on the interaction term between changes in relative productivity and changes in the exchange rate is positive (3.803 from Column 4). Both are statistically significant.

These results clearly show that higher Canadian than U.S. productivity growth translates into a relatively lower Canadian than U.S. output price and thus increases a Canadian industry's international competitiveness. The Canada–U.S. findings on the effects of productivity are consistent with studies for Hungary (Losoncz, 2004) and the Nordic countries (Alexius, 2001), where productivity is found to be the most important determinant of international competitiveness.

But our results also show that in the short run the degree of pass-through from productivity to price varies across exchange-rate cycles. In periods of an appreciating Canadian dollar, U.S. products valued in Canadian dollars become relatively cheaper. The resulting price pressure motivates Canadian producers to pass on more gain from relatively high productivity growth to consumers in terms of lower output prices than they do in periods of a depreciating Canadian dollar. Differences in competitive pressures in the two exchange-rate regimes (appreciation versus depreciation) impact on the extent to which productivity gains are passed on to consumers.

Our second finding is that there is a pass-through from increases in input prices to increases in output prices, and the pass-through from production costs to output prices is not sensitive to the exchange-rate movements. This is demonstrated by the significant positive correlation between changes in relative prices and changes in relative input costs for both the appreciation periods (0.509 from Column 1) and depreciation periods (0.573 from Column 2), and the insignificant coefficient on the interaction term between changes in relative input costs and a time dummy for the depreciation periods (0.065 from Column 3). Results using specification (5) are consistent with those from Columns (1) to (3): the coefficient on the changes of relative input costs is significantly positive (0.501 from Column 4), and the coefficient on the interaction term between changes in relative input costs and changes in the exchange rate is statistically insignificant. Higher Canadian than U.S. input cost increases translate into relatively higher Canadian than U.S. output prices and thus decreases a Canadian industry's international competitiveness.

Our third important finding is that the relative Canada–U.S. price is less volatile for more export-intensive industries over exchange-rate cycles. Columns (1) to (3) show that changes in the relative price are negatively correlated with average export intensity when the Canadian dollar appreciates (-0.013 from Column 1), but positively correlated when the Canadian dollar

depreciates (0.011 from Column 2). When the Canadian dollar appreciates, U.S. products in Canadian dollars become cheaper, and the average Canadian price increases relative to the exchange rate-corrected U.S. price. The negative correlation during the appreciation periods indicates that the price ratio increases less when there is a larger proportion of production exported. When the Canadian dollar depreciates, U.S. products in Canadian dollars become more expensive, and the average Canadian price falls relative to the exchange rate-adjusted U.S. price. The positive correlation during the depreciation periods indicates that the price ratio declines less when a larger percentage of Canadian production is exported. This is consistent with the results in Schembri (1989) on Canadian export pricing, and the pricing-to-market phenomenon.

Results from alternative specification (5) further confirm the results from Columns (1) to (3). The coefficient on the interaction term between export intensity and changes in the exchange rate is significantly positive (0.484 from Column 4), indicating that industries with different export intensities adjust differently to changes in the exchange rate. It is consistent with a world in which Canadian exporters adjust their output prices in Canadian dollars more to fluctuations in the exchange rate than is the case for domestic production destined for domestic markets, so that the export selling prices in the foreign currency (U.S. dollars) remain relatively more stable. In pricing their products to the foreign market, Canadian exporters absorb at least some of the fluctuations in the exchange rate through their profits. As a result, the relative price for exporters fluctuates less than that for non-exporters as the exchange rate changes.

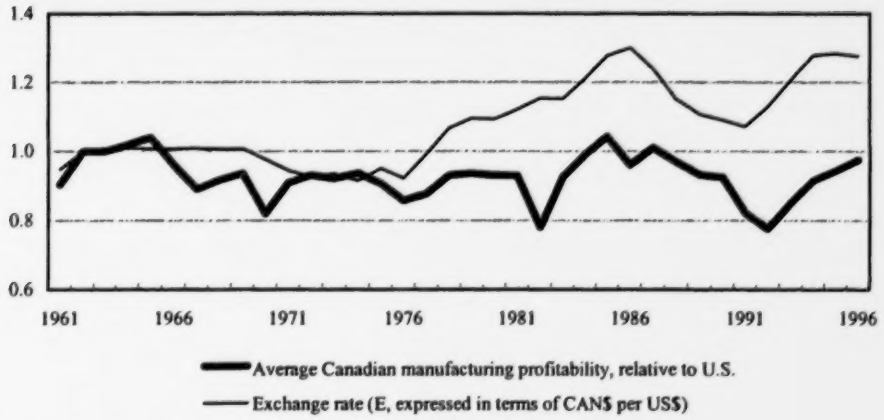
Given that around 38% of Canadian manufactured goods over 1970 to 1996 are exported, we might expect the average profitability of Canadian manufacturing industries to fluctuate with the exchange-rate movement. Figure 2 plots the exchange rate and the average manufacturing profitability in Canada relative to the U.S.[16] It confirms that the fluctuation in profitability is positively correlated with the movement in the exchange rate. The average profit for Canadian industries, relative to the U.S., declines when the Canadian dollar appreciates, and increases when the Canadian dollar depreciates.[17]

After controlling for exchange-rate movements, there are, on average, no significant differences in the changes of relative prices between more- and less-export intensive industries, as demonstrated by the statistically insignificant coefficient on the export-intensity (-0.014) from Column (4) of Table 2. Export-intensity itself, therefore, does not have any direct impact on the changes of relative price or the shifts in the competitiveness of Canada and U.S. products in the long-run. Its impact lies in its interaction with shocks to the economy, such as an exchange-rate movement. Industries with a higher proportion of exports react differently to changes in the exchange rate than do industries that are less export intensive. As a result, their competitiveness, relative to foreign countries, also changes differently over cycles of the exchange rate.

Our next important finding is that the relative price fluctuates more for industries with higher domestic competition over exchange rate cycles. Columns (1) to (3) of Table 2 show that the correlation between the average changes in the relative price and the intensity of competition is positive when the exchange rate appreciates (0.002 from Column 1), but negative when it depreciates (-0.001 from Column 2). Their difference is significant at the 5% level (the

16. Profitability is defined as value added minus wages and salaries over total value of sales.
17. The correlation between the relative profitability and the exchange rate is 0.36 for the period from 1970 to 1996.

Figure 2 Exchange rate and relative profitability



Source: Canadian data based on Capital, Labour, Energy, Materials and Services (KLEMS) database, American data based on the National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies (NBER-CES) productivity database.

coefficient on the interaction term between the intensity of domestic market competition and a time dummy for the depreciation periods: -0.003 from Column 3). When the Canadian dollar appreciates, U.S. products in Canadian dollars become cheaper, the Canadian price increases relative to the exchange rate-corrected U.S. price. The positive correlation during the appreciation periods indicates that the price ratio increases more when the intensity of competition in the domestic market is higher. When the Canadian dollar depreciates, U.S. products in Canadian dollars become more expensive, and the Canadian price falls relative to the exchange rate-adjusted U.S. price. The negative correlation during the depreciation periods indicates that the price ratio declines more when the industries are more competitive.

The results from alternative specification (5) further confirm the results from Columns (1) to (3). The coefficient on the interaction term between domestic market competition and changes in the exchange rate is significantly negative (-0.049 from Column 4), indicating that industries that differ in terms of the intensity of competition adjust differently to changes in the exchange rate. In markets with more domestic competition, there is less adjustment of domestic prices to changes in the landed prices of U.S. goods. As the domestic market becomes more competitive, the room for domestic prices to adjust to U.S. landed prices is reduced. The relative price for more competitive industries fluctuates more than that for more concentrated industries during cycles in the exchange rate.

As in the case of export intensity, the intensity of domestic market competition does not have any direct impact on the changes of relative price in the long run, as evidenced by the insignificant coefficient on domestic market competition (0.004) from Column 4. Its impact lies in its interaction with shocks to the economy, such as the exchange-rate changes.

We also find that the rate of adjustment is not related to import share, as we might have expected from Dornbusch and Sibert or from the pricing-to-market hypothesis. This may have occurred if the impact of import share depends upon the competitiveness of the market. We therefore experimented with an interaction term between import share and domestic concentration, but found that it too was insignificant.

One explanation for the insignificant impact of import shares may lie in measurement problems. It may be that import share is not a good proxy for the ratio of the number of foreign firms to total firms as in Dornbusch and Sibert's models. It may also be that imports of commodities may be both competing with final products and intermediate inputs and distinctions need to be drawn between the two in future research. Another explanation is that if there is market segmentation affecting import pricing, it may not be directly related to the importance of imports. In fact, our finding of the insignificant impact of import shares suggests that import prices are generally being set in U.S. dollars as is our finding for Canadian exports. The lack of pricing-to-market in U.S. export industries may also be related to the presence of multinational operations where transfer pricing is common (Rangan and Lawrence, 1993), or to the practice of invoicing in U.S. dollars instead of Canadian dollars (Page, 1981).

Finally, we do not find any significant impact of changes in the relative production scale and product differentiation on the trends or volatility of relative output prices.

5. *Conclusion*

Over the last 40 years, the Canadian–U.S. exchange rate has gone through several long cycles, alternating between periods of appreciation and depreciation. During each of these cycles, the competitiveness of the Canadian manufacturing sector has changed dramatically. During periods of exchange rate appreciation, the competitiveness of Canadian industries, as measured by the relative price ratio between the Canadian price and exchange rate-adjusted U.S. price, has on average declined; during periods when the Canadian dollar depreciated, it increased.

Not all industries experienced the same change in prices relative to their U.S. counterparts. In this paper, we explored which characteristics are related to the rate at which the price ratio increases or decreases over periods of exchange-rate appreciation or depreciation. We find that production costs, such as the costs of labour, energy and material, and productivity growth are the two most important determinants of international competitiveness.

The movement of the Canada–U.S. exchange rate is sometimes attributed to changes in productivity of the Canadian economy relative to its trading partners. Implicit in this explanation is the belief that superior productivity performance leads to lower prices and lower prices result in higher demand for Canadian exports and lower imports. At least for the manufacturing sector, this paper illustrates that there is substantial (though not complete) pass-through from relative productivity growth to relative price changes.

But the paper also demonstrates that the amount of pass-through is not constant. It is greater in periods of exchange rate appreciation when competitive pressures from United States goods are greater. It is lower in periods of depreciation when competitive pressures from United States goods are less. Competitive pressures emanating from trade are therefore important determinants of the extent to which relative productivity differences in manufacturing are passed through to cross-country price differences in the short run.

It is also the case that the size of the relative price movement over the cycles of the exchange rate depends on the export intensity of the industry and the degree of domestic market competition. For industries that are more export-intensive or more concentrated, their relative prices are less affected by fluctuations in the exchange rate. This is consistent with a world in which Canadian exports are priced exactly or closely to U.S. levels, and changes in the exchange rate will therefore be passed directly through to the average Canadian price charged. This is also consistent with a world in which markets with less domestic competition are more able to adjust their prices to landed U.S. prices, and changes in the exchange rate will therefore be passed directly to Canadian prices. In such a world, exporters or industries with market power adjust to competitive pressures from trade over the cycles of exchange rate by squeezing or swelling their profit margins.

We find that the rate of adjustment of Canadian–U.S. prices is much less affected by industry characteristics related to the production scale, import penetration and the degree of product differentiation between domestic products and foreign imported products.

Appendix: Summary statistics—averages over the period [1]

Period	Quintile	Average annual changes[2]				Export intensity (*EXP*)	Domestic market competition[3] (*COM*)	Product differentiation[4] (*DIF*)	Import share (*MSH*)
		Canadian prices relative to U.S. prices adjusted by exchange rate ($dln(RP)$)	Canadian productivity, relative to U.S. ($dln(A^c/A^u)$)	Canadian input cost, relative to U.S. ($dln(C^c/C^u)$)	Canadian output, relative to U.S. ($dln(Q^c/Q^u)$)				
Period of exchange rate appreciation									
1970 to 1976	top	-0.001	0.018	0.012	0.025	0.207	-0.427	0.526	0.305
1970 to 1976	bottom	0.042	-0.013	0.027	-0.005	0.142	0.124	0.520	0.220
1986 to 1991	top	0.007	0.009	0.030	0.000	0.439	-0.326	0.689	0.392
1986 to 1991	bottom	0.050	-0.025	0.040	-0.037	0.159	0.333	0.527	0.307
Correlation coefficient[5]		...	-0.754	0.480	-0.425	-0.237	0.235	-0.081	-0.151
			(<0.0001)	(<0.0001)	(<0.0001)	(0.030)	(0.032)	(0.464)	(0.172)
Period of exchange rate depreciation									
1976 to 1981	top	-0.043	0.018	-0.032	0.011	0.199	0.090	0.575	0.266
1976 to 1981	bottom	-0.001	-0.005	-0.018	0.001	0.241	-0.568	0.602	0.309
1981 to 1986	top	-0.026	0.016	-0.016	0.027	0.287	0.272	0.597	0.362
1981 to 1986	bottom	0.010	-0.003	-0.002	-0.001	0.228	-0.311	0.688	0.264
1991 to 1996	top	-0.045	0.004	-0.032	-0.002	0.193	0.064	0.688	0.234
1991 to 1996	bottom	-0.004	-0.019	-0.019	-0.003	0.514	-0.537	0.700	0.458
Correlation coefficient[3]		...	(-0.462)	0.372	-0.268	0.198	-0.150	0.067	0.182
		...	(<0.0001)	(<0.0001)	(0.003)	(0.025)	(0.090)	(0.455)	(0.040)

... not applicable

1. Averages are calculated as averages over an entire period.
2. Annual average change of a variable is calculated as the difference between the log value of the last and first year of the variable divided by the number of years.
3. The first principle component is used as a measure for domestic market competition.
4. Grubel intra-industry trade index is used as a measure of product differentiation between domestic and imported foreign products.
5. This is the correlation between average annual changes of the relative Canadian price to exchange rate-adjusted U.S. price and other industry variables. It is estimated by pooling all top and bottom quintile observations over the two periods. The *p*-value, which is the significance probability of the correlation, is in parentheses.

Source: Canadian data based on Capital, Labour, Energy, Materials and Services (KLEMS) database and on the Annual Survey of Manufactures (ASM) and on Input/Output tables, American data based on the National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies (NBER-CES) productivity database.

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